Evaluations of Risks from the Lunar and Mars Radiation Environments

MYUNG-HEE Y. KIM,[1] MATTHEW J. HAYAT,[1] ALAN H. FEIVESON,[2]
and FRANCIS A. CUCINOTTA[2]

[1]*Universities Space Research Association, Division of Space Life Sciences, Houston, Texas, USA*

[2]*NASA Johnson Space Center, Space Radiation Program Element, Houston, Texas, USA*

Protecting astronauts from the space radiation environments requires accurate projections of radiation in future space missions. Characterization of the ionizing radiation environment is challenging because the interplanetary plasma and radiation fields are modulated by solar disturbances and the radiation doses received by astronauts in interplanetary space are likewise influenced. The galactic cosmic radiation (GCR) flux for the next solar cycle was estimated as a function of interplanetary deceleration potential, which has been derived from GCR flux and Climax neutron monitor rate measurements over the last 4 decades. For the chaotic nature of solar particle event (SPE) occurrence, the mean frequency of SPE at any given proton fluence threshold during a defined mission duration was obtained from a Poisson process model using proton fluence measurements of SPEs during the past 5 solar cycles (19-23). Analytic energy spectra of 34 historically large SPEs were constructed over broad energy ranges extending to GeV. Using an integrated space radiation model (which includes the transport codes HZETRN [1] and BRYNTRN [2], and the quantum nuclear interaction model QMSFRG[3]), the propagation and interaction properties of the energetic nucleons through various media were predicted. Risk assessment from GCR and SPE was evaluated at the specific organs inside a typical spacecraft using CAM [4] model. The representative risk level at each event size and their standard deviation were obtained from the analysis of 34 SPEs. Risks from different event sizes and their frequency of occurrences in a specified mission period were evaluated for the concern of acute health effects especially during extra-vehicular activities (EVA). The results will be useful for the development of an integrated strategy of optimizing radiation protection on the lunar and Mars missions.

Keywords: Space Radiation Environments; Galactic Cosmic Radiation; Solar Particle Event; Radiation Risk; Risk Analysis; Radiation Protection.

References

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